

Nomination of

Hydraulic Power in Sydney

‘The Power of the Age’

for

Cultural Heritage Recognition



Former No.1 Pumping Station, Darling Harbour

**John Gibson & Michael Clarke
for Engineering Heritage Sydney
May 2020**

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Nomination letter

The Administrator
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Name of Cultural Item:

Hydraulic Power in Sydney – ‘The Power of the Age’, recognising the service provided by the works of the Sydney and Suburban Hydraulic Power Company (SSHPC) and installations by others. (The sub title ‘The Power of the Age’ is from an SSHPC paper of 28 March 1891).

Nature of the Award:

The cultural heritage of the provision of hydraulic power in Sydney city is nominated for the award of an Engineering Heritage Marker.

Location:

Within the boundaries of the City of Sydney’s Central Business District as framed by Woolloomooloo, Circular Quay, Walsh Bay, the former Grace Bros Broadway, and Pyrmont.

Owner of No.1 pumping station & site of interpretation:

Place Management NSW, Department of Planning, Industry & Environment, PO Box N408, Grosvenor Place NSW 1220.

The owner has been advised of this nomination and a letter of agreement is below.

Access to Sites:

Remnants are generally publicly visible, and some are accessible, especially the former No. 1 pumping station. Access to a few items within buildings might be gained from the relevant authority and current lessees.

Nominating Body:

Engineering Heritage Sydney

Frank Johnson
Chair
Engineering Heritage Sydney
.... 2020



28 May 2020

Stephen Lockhart
Secretary, Engineering Heritage Sydney
Engineers Australia, Sydney Division
Level 3, 8 Thomas Street,
Chatswood NSW 2067

Dear Mr Lockhart,

Re: HERITAGE RECOGNITION OF HYDRAULIC POWER IN SYDNEY

I refer to your letter of 6 March regarding the proposed interpretation of the above. I would also like to offer my sincere apologies for the lateness in reply; the arrival of your letter coinciding with the "lockdown" due to the COVID-19 pandemic, and the resulting rearrangement of working arrangements.

Place Management NSW (PMNSW) is proud of its heritage assets and has as part of its core-business the promotion of these significant items. The Hydraulic Pumping Station at Pier Street, Darling Harbour is one such asset which is recognised as an item of State Significance of the NSW Heritage Register.

A Conservation Management Plan of the Hydraulic Pumping Station was recently updated, benefiting significantly from the advice of John Gibson, who is a long-term member of the Engineering Heritage Committee of Engineers Australia. The CMP can be accessed via the following link:
<http://www.baseline.nsw.gov.au/hpr/documents/public/241/reference/3040.pdf>

PMNSW encourages the input of the public in the promotion of its history and heritage, and therefore gratefully acknowledges the prospect of partnering with Engineers Australia in the installation of interpretative information about the hydraulic power system in Sydney in the 19th and 20th centuries.

I have spoken with John Gibson and Michael Clarke in the past weeks regarding appropriate commemoration of the Hydraulic Pumping Station and familiarised them with the general guidelines adopted by PMNSW to present such information. As you will understand, the current COVID-19 restrictions have for the moment brought a halt to many of the activities of Place Management NSW. While we cannot commit to any concrete plans at the moment, PMNSW is happy to discuss options for interpretative works that might be installed and promoted at a later date. In the meantime I draw your attention to section 7.18 in the Conservation Management Plan (link above), and elsewhere in that document, which specifically deal with opportunities and themes for interpretation.

I look forward to further discussions as to how we can further an interpretation project for the Hydraulic Pumping Station as social and economic conditions improve.

Sincerely,

Dr Wayne Johnson
Senior Archaeologist,
Strategic Planning and Heritage
Place Management NSW

Basic Data

Name of physical items:

Only fragments now exist of Sydney's hydraulic systems: the Sydney & Suburban Hydraulic Power Company's system that was comprised of a dam, pumping stations and a city-wide reticulation system, and of localised private installations.

Other/former names of works: Sydney & Suburban Hydraulic Power Co; Hydraulic Power Pty Ltd, as well as other companies that installed stand-alone systems.

Location: Within the area of the City of Sydney bounded by Woolloomooloo, Circular Quay, Walsh Bay, the former Grace Bros store at Broadway, and Pyrmont.

Address: Main remnant and site of interpretation – former No.1 pumping station (now part of the Novotel Hotel), 17 Little Pier Street, Darling Harbour, Sydney NSW.

Local Govt. area: Sydney

Owner: Various owners both private and public viz: Place Management NSW for former No.1 pumping station and whips on buildings in The Rocks; City of Sydney for defunct reticulation within public streets and roads; and various private owners for other installations.

Current use: Defunct

Former use: A variety of remnant plant and lifting devices throughout the city, and the hydraulic water systems that powered them.

Year started (by major power supplier): Sydney & Suburban Hydraulic Power Company, 1889.

Year completed (major power supplier): Sydney & Suburban Hydraulic Power Company, 1891 (initial installation).

Ceased operation (major power supplier): Hydraulic Power Pty Ltd, 1976.

Physical condition of remnants: Varies from good to poor. While the former No. 1 pumping station has been extensively renovated the building is in good repair and the accumulators and cast-iron tanks remain; the building is currently a bar and is occupied by lessees, including the Novotel Hotel.

Various whips, a crane and some other machines are in good condition on the facades of buildings, remnants of lifts are in poor condition, while remnants of wool handling machinery exist at Walsh Bay, with some interpretation.

The hydraulically operated door of the Commonwealth Bank at 48-50 Martin Place, was disabled in 2019 and replaced with a conventional door. However, it is still in place in its lowered position.



Prominent sites in the area served by Sydney & Suburban Hydraulic Power Company

1. Executive Summary

Only fragments now exist of the Sydney & Suburban Hydraulic Power Company's system (comprised of a dam, pumping stations, and a city-wide reticulation system), and of localised private installations. Consequently, the purpose of this nomination is to recognise the significant cultural heritage of hydraulic power in Sydney city, and to inform the public about its contribution to the development of the city.

In the 1880s Sydney was a burgeoning city and as there were no electricity or petroleum engines, power was needed for operating mechanical systems and devices as an alternative to using stairs, and to lift loads into tall buildings - three storeys and higher!

To cope with this problem on an individual basis, a number of privately owned hydraulic systems began operating hoists and lifts.

Subsequently, to address the need on a city-wide scale, in 1889 a group of businessmen formed the Sydney and Suburban Hydraulic Power Coy (SSHPC) and developed a hydraulic system that piped high-pressure water at 750 psi around the city to power all sorts of devices such as cranes, whip-hoists/jiggers, wool presses (dumps), goods and passenger lifts, and even heavy bank doors.

Water initially came from the Water Board's mains but later the Company built a storage dam at Waterloo from which it pumped water to the No. 1 pumping station in Pier Street, Darling Harbour - now part of the Novotel Hotel.

The company ceased operations in 1976 leaving the No.1 pumping station the most visible part of its system. However, many pipes and valves are still under footpaths, some surface boxes can be found, a few whips remain on the external walls of one-time warehouses, and there are also some remnants of lifts.

Early installations in new government buildings were lifts in the Chief Secretary's Building in about 1892, and the Lands Department Building in around 1894.

There were also stand-alone (private) systems i.e. not connected to the mains, e.g., in the Queen Victoria Building (QVB) there were six large lifts that could take a horse and cart from street level down to the vegetable markets in the basement (the lifts have long been removed), and there were installations at the Argyle Stores, and at Walsh Bay wharf for wool handling and bale pressing, and at Woolloomooloo finger wharf which became one of the major wool dispatch points and the site of one of Sydney's wool dumps - where wool bales were compressed by hydraulic rams.

Outside the area specifically covered by this nomination there were installations at the Garden Island Naval Dockyard (which still exists in good repair), Eveleigh and Chullora railway workshops and Cockatoo Island Dockyard, and the remnants of systems exist at some other industrial sites.

Statement of Significance:

Provision of hydraulic power in Sydney is of cultural heritage significance because:

it played a pivotal role in the industrial, commercial, and architectural development of Sydney. It provided major improvements in the handling of wool, in vertical transportation of passengers, the lifting of goods, and in the building industry, with

the latter permanently altering the city profile. It continued to provide an essential service to the city for nearly 90 years.

As little is known by the general public of the use of hydraulic power in Sydney, the former No. 1 pumping station and the publicly visible remnants of various machines and applications are of major social interest as a significant part of the tangible evidence of the city's industrial history.

Interpretation:

After discussion with Place Management NSW's representative, it has been determined that interpretation would be best placed at the former No. 1 pumping station. However, as the standard interpretive panel would not be appropriate for such a busy, paved, city place, it is proposed to adopt an interpretive style used by the authority in similar places. This could be like that at the old police station in The Rocks, which involves engraved bluestone blocks with images, set in the pavement – see Images. There could be a number of panels to tell the story.

Negotiation on the form and provision of interpretation/recognition, will be held with Place Management when precautions relating to Covid19 permit.

Recommendation:

It is recommended that *Hydraulic Power in Sydney – 'The Power of the Age'*, be awarded an Engineering Heritage Marker.

2. Historical review

At the end of the 19th century before electric motors were perfected, the principal sources of power for industry and commerce were steam engines, some gas engines and hydraulic power. A public system of high-pressure hydraulic (water) power was introduced to Sydney in 1891. Before that, several privately owned hydraulic systems were operating hoists and lifts. The public network was crucial to the docks, warehouses, and other commercial developments of Sydney.

The effect of the introduction of hydraulically powered lifts on the architecture of Sydney was dramatic. Commercial, residential and warehouse buildings could now be constructed up to eight storeys high instead of the usual three or four. Builders were quick to seize on the new technology and use it to meet the mounting commercial pressure for more buildings on less land.

The Sydney and Suburban Hydraulic Power Company was established in 1889 and its No.1 pumping station was completed in Pier Street in 1891. By 1926 the Company's operations had expanded and the more efficient electric lifts were being installed and maintained by it in many of Sydney's buildings. The company then became 'Hydraulic Power Electric and Hydraulic Lifts Ltd'.

In 1955 the company, in an attempt to prevent a takeover by the Council of the City of Sydney, split into 'Elevators Pty Ltd' and 'Hydraulic Power Pty Ltd'. These two companies were taken over by Lend Lease Corporation in 1960.

The Pier Street station was the first and largest pumping station in Sydney. Sited between the central business district and the wool presses of the Pyrmont and Ultimo wool stores, it provided water at 750psi in an area bounded by Grace Bros store in Broadway, the Pyrmont wharves, Circular Quay, and the eastern end of Cowpers Wharf Road, Woolloomooloo.

Water for the system was tapped initially from the city water supply. However, as demand for service increased this became too expensive and a dam was constructed on 4ha of land near Mount Rennie, which is now the Moore Park Golf Club, with water being pumped by the low-pressure Waterloo pumping station to a tank at the Pier Street pumping station reservoir. The dam was later increased in size from 2.8 million litres to 4.5 million litres.

High pressure water from the Pier Street station was pumped through 150mm and 100mm high pressure mains to operate many of the lifts, hoists, cranes, bank doors and wool dumping presses scattered throughout the city, and even to some church organs.

In 1903 the NSW Department of Labour and Industry reported that it had registered 522 hydraulic lifts, and that the Sydney and Suburban Hydraulic Power Company had laid some 50 miles (80km) of supply pipe throughout the Sydney central business district.

Early installations in new government buildings were lifts in the Chief Secretary's Building in about 1892, and the Lands Department Building in around 1894.

There were also stand-alone (private) systems i.e. not connected to the mains, e.g., in the Queen Victoria Building (QVB) there were six large lifts that could take a horse and cart from street level down to the vegetable markets in the basement (the lifts have long been

removed), and there were installations at the Argyle Stores - for lifting loads, and at Walsh Bay wharf for wool handling and wool bale compressing by hydraulic rams, and at Woolloomooloo finger wharf - which became one of the major wool dispatch points, also for wool bale compressing.

One stand-alone system was installed in Anthony Hordern's department store, two years before the Sydney & Suburban Hydraulic Power Company's system began operating. A Powerhouse Museum publication reports that:

"...In 1889 the engineer Norman Selfe installed one of Sydney's first passenger lifts in Anthony Hordern's Palace Emporium on George Street, Haymarket. Lucien Henry designed the décor of the lift car. When completed in 1889, Anthony Hordern's Palace Emporium was the largest department store in Sydney. At 35 metres in height it was briefly Sydney's tallest building".

Passenger lifts were one of the new technologies that made tall buildings possible. Suspended cable lifts were widely believed to be dangerous, and until the 1920s hydraulic lifts were used in most new city buildings in Sydney".

After a fire destroyed the Palace Emporium in 1901 Horderns built its New Palace Emporium that opened in 1905. It was a huge building having five storeys (another was added in 1914-15) and it included 21 hydraulic lifts. This was probably the largest installation in Sydney, but whether it was a stand-alone system or was connected to the Sydney & Suburban Hydraulic Power Company's system, is yet to be determined

By the 1920s hydraulic pumping sub-stations had been erected by the Sydney and Suburban Hydraulic Power Company at Cowpers Wharf Roadway, Woolloomooloo, and at Pyrmont, to cope with the increased demand, principally from the wool presses. In 1926 the Waterloo pumping station was converted from steam to electricity and the first change in the Company's name occurred.

The demand for power increased steadily to 250 million litres/year and in 1952 the steam plant at Pier Street was replaced by electric pumps to try and meet this demand. The growth of the number of lifts and hoists operated by hydraulic power increased steadily from 1891 to the 1920s when electrically powered lifts became pre-eminent. From the 1920s most new buildings had electric lifts installed as hydraulic lifts were seldom suitable for more than four or five storeys, and the number of lifts remained relatively static. However, the increased use of hydraulic lifts already in place led to a steady increase in the amount of water consumed up until the late 1950s.

There was a steady decline in the demand for hydraulic services from the commencement of the 1950s building boom - the break-even point occurred around 1965, and there was also a need to upgrade much of the plant. Consequently, the decision was made to cease operations by 1975, with the high-pressure water supply being discontinued in sections.

The former pumphouse has since been leased and is now part of the Novotel hotel.

Outside the area specifically covered by this nomination there were installations at the Garden Island Naval Dockyard (which still exists in good repair), Eveleigh and Chullora railway workshops, and at Cockatoo Island Dockyard, and the remnants of systems exist at some other industrial sites.

3. Physical Description of some remnants

4.1 Former No. 1 pumping station

The station has a three-storey Italianate/Baroque facade with rich decorative plaster/stucco elements. Detailing includes matching pairs of pedimented dummy windows, with square Corinthian pilasters flanking a central arched window on each storey, also with Corinthian pilasters plus stucco moulding and keystone. The facade of the third story of the accumulator house rests on a corbelled string course and consists of a returning balustrade, punctuated by impressive pillar and stylised pediment which reads in relief 'SYDNEY SUBURBAN HYDRAULIC POWER ESTD COMPANY 1889'.

The building still houses two accumulator cylinders. The walls are massive load-bearing brick with a riveted iron girder and timber ceiling. The Engine House behind and adjacent to the accumulator house, supports a huge cast iron water tank on massive load bearing brick walls and a double row of large riveted iron box girders. The water tank is constructed of large square cast iron plates with raised circular and diagonal strengthening ridges on the interior. Cast inscriptions on two of the plates on the tank read 'J COATES ENGINEER COLLINS STREET MELBOURNE' and 'J ABBOT & CO LD MAKERS GATESHEAD ENGLAND'.

The interior of the building (now a bar) has been massively renovated with only the original walls and ceiling remaining; there is no demarcation between the original two buildings evident on the interior. A verandah with balcony above has been added to the western wall.

4.2 Argyle Stores

In the courtyard (now a bar) is a whip, rigged to lift loads on each side, into a four-storey former warehouse. It bears an oval cast-iron maker's plate reading 'TANNET WALKER & Co. 1885, LEEDS'.

This was a private (stand-alone) system with pump, the gas engine and accumulator located in the basement of the south wing (now male/female toilets).

The whip was restored by the Sydney Harbour Foreshore Authority, and an interpretative panel placed on an adjacent wall.

4.3 Walsh Bay

On wharves 8/9 Walsh Bay and in the adjacent shore shed, there was a self-contained i.e. stand-alone, steam-driven hydraulic power system that until the 1950s, operated lifts, wool bale presses, bale conveyors for ship loading, and cranes.

In converting the wharf for apartments c.2000, parts of the system were displayed, and interpretive panels installed.

The hydraulic pumps are in part of the shore shed which is now a restaurant. There are four pumps, two on each side of a flywheel, with each pair coupled by a connecting rod.

While the system was originally steam-driven it now has a 65 HP electric motor.

An accumulator is displayed adjacent the store shed with bricks providing the load on the piston, but it is neither original nor is it in its original position.

A goods lift is still in-situ, and a wool bale lift has been relocated close by. The goods lift has its original cylinder/ram and pulleys.

A feature of the wool bale lift was the use of a loading platform that could be raised or lowered to allow bales to be slid straight off a truck onto the platform and into the lift.

Originally there was also a passenger lift operated by a hydraulic ram; it ceased in 1984 when the system was condemned.

4.4 Woolloomooloo Finger Wharf

In the early 1920s Woolloomooloo Finger Wharf became one of the major wool dispatch points, and the site of one of Sydney's wool dumps - where wool bales were compressed by hydraulic rams.

The wharf contains a number of significant items of industrial archaeology. Originally, eight electrically driven bale elevators and four electric lifts were provided.

Usage of the wharf declined by the 1970s and by the 1980s it lay derelict and empty. After being saved from demolition by a strong public outcry, it was redeveloped as a fashionable complex housing a hotel, restaurants, and residential apartments.

4.5 Lifts at McLaughlin and Co Ltd, 185 Clarence Street, Sydney

On 20 May 1935 McLaughlin and Co Ltd were connected to the Sydney Hydraulic Power Company's (SHPC) system at a fee of £3/quarter/machine.

When inspected in 2014 the building had three lifts in-situ. Two were set up side by side as goods lifts ranging from ground level to level 5 (six floors). A third but later installation, was an electrically powered 'dumb waiter' type of lift ranging over three levels only.

In the sub-basement area at the Clarence Street end of the building were the remnants of a third hydraulic powered lift that was also operated from the SHPC system. This lift had all its equipment extant – supply pipes, control valves, water meter, valves, etc. The original cage and shaft surround that were made of timber (but which are now badly rotted), were in-situ. The cylinder and ram were evident, but without lighting it was not possible to study these in detail.

On the footpath outside the building there are two SHPC stop valve covers that enabled the building to be isolated from the mains in case of a fault.

The connection continued until 1975 when the Sydney Hydraulic Power system closed. Afterwards, the building's system was changed to oil hydraulic pumps.

The electrically driven hydraulic oil pumps were located on level six. When inspected, the two goods lifts appeared to be in reasonable condition. However, current redevelopment of the building site has meant that the lift remnants have been removed and stored. A heritage precinct is to be developed within

the refurbished building recognising the significance of the hydraulic lift system to the city.

4. Heritage Assessment

5.1 Historical Significance

Provision of hydraulic power was directly associated with the development of many prominent Sydney firms and with the construction of many prominent Sydney buildings. It was an important contributing factor in the development of commerce and industry in Sydney, including the operations of the Pyrmont and Darling Harbour wool stores, and the wool boom of the 1890s. Hydraulic power led directly to changes in the building industry which permanently altered the city profile, and continued to provide an essential service to the city for nearly 90 years.

5.2 Association with Historic Individuals

Nil

5.3 Creative or Technical Achievement

Hydraulic power was an efficient and effective solution to the growing need for a reliable and affordable power source for industry, commerce, and the development of taller buildings.

5.4 Research Potential

The provision of hydraulic power has informed research into the development of taller buildings, commerce, and industry in Sydney, and may further do so.

5.5 Social Significance

The advent of hydraulic power altered forever the conditions and environment of Sydney's office workers.

The former No. 1 pumping station is a well-known landmark at the southern end of Darling Harbour and is the last major vestige of a suite of industrial structures in and around that area.

As little is known by the general public of the use of hydraulic power in Sydney, No. 1 pumping station and the publicly visible remnants of various machines and applications are therefore of major social interest as the principal tangible evidence of the city's industrial history.

5.6 Rarity

No. 1 pumping station was the first and largest hydraulic pumping station to be built in Sydney. It is the last major vestige of the industrial history of Darling Harbour.

The few remaining hydraulically operated whips, cranes, lifts, remnants of wool-loading machinery and chutes at Walsh Bay, and valve surface boxes in footpaths, are rare, and are becoming increasingly so as development and roadworks occur.

5.7 Representativeness

The visible remnants of the various hydraulic power systems – the whips, wool-handling machinery, valve surface boxes and particularly the former No. 1

pumping station, are representative of the important role that hydraulic power played in developing the architecture, commerce and industry of Sydney.

5.8 Integrity/Intactness

While the installations at Walsh Bay, Eveleigh and at Garden Island have the major components in place, they are not operational.

Remnants of machinery consist of whips, cranes and a lift piston on former warehouses, wool-handling machinery, and valve surface boxes. At the former No. 1 pumping station, the building facade, internal walls, roof, hydraulic accumulators, and the large cast iron water tank still survive, and were sympathetically incorporated in the building when it was renovated as a pub.

6 Statement of Significance

Provision of hydraulic power in Sydney is of cultural heritage significance because: it played a pivotal role in the industrial, commercial, and architectural development of Sydney. It provided major improvements in the handling of wool, in vertical transportation of passengers and goods, and in the building industry, with the latter permanently altering the city profile. It continued to provide an essential service to the city for nearly 90 years.

As little is known by the general public of the use of hydraulic power in Sydney, No. 1 pumping station and the publicly visible remnants of various machines and applications, are of major social interest as a significant part of the tangible evidence of the city's industrial history.

7 Interpretation

After discussion with the archaeologist of Place Management NSW - the person responsible for interpretation, it has been determined that interpretation would be best placed at the No. 1 pumping station. However, as the standard interpretive panel would not be appropriate for such a busy, paved, city place it would be best to adopt an interpretive style used by the authority in similar places - see images of the interpretation at The (old) Rocks Police Station.

Negotiation on the form and provision of interpretation/recognition, will be held with Place Management when precautions relating to Covid19 permit.

8 Recommendation

It is recommended that *Hydraulic Power in Sydney – 'The Power of the Age'* be awarded an Engineering Heritage Marker.

9 Images

Former No.1 Pumping Station



No.1 pumping station - northern elevation



Maker's plate – day tank



No.1 pumping station - accumulator building, 'day tank' on engine house, & added verandah on western frontage

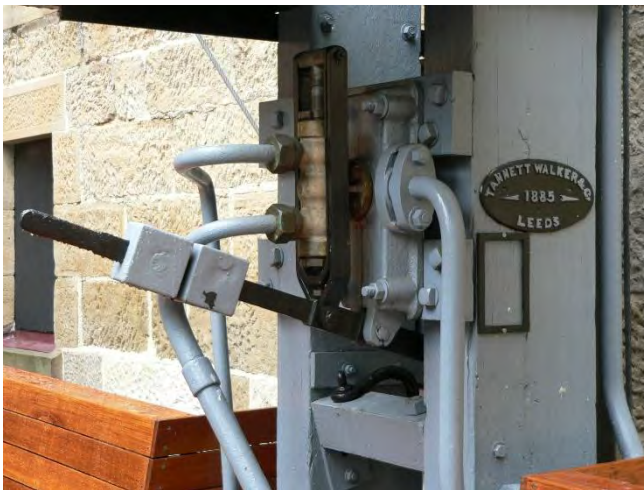
Whip – Argyle Stores



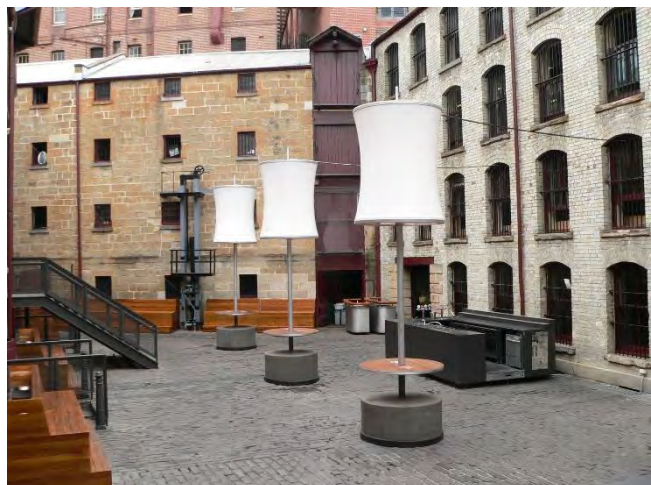
**Whip before conservation
- Argyle Stores courtyard**



**Whip after conservation -
Argyle Stores courtyard**



Control, & maker's plate - Tannet Walker & Co. 1885,



Argyle Stores courtyard – whip and bar



Whip – Campbells Cove



Hydraulic lift piston, Hickson Road



Horse & cart lift, Queen Victoria Building



**Sydney Hydraulic Power Company
surface box**



Hydraulic Power Co. surface box



Hydraulic Power Co. surface box



**Crane, Royal Edward Victualing
Yard, Darling Island, Pyrmont**



Wool press/dump/intensifier



**Commonwealth Bank, Martin Place;
hydraulic door closed**

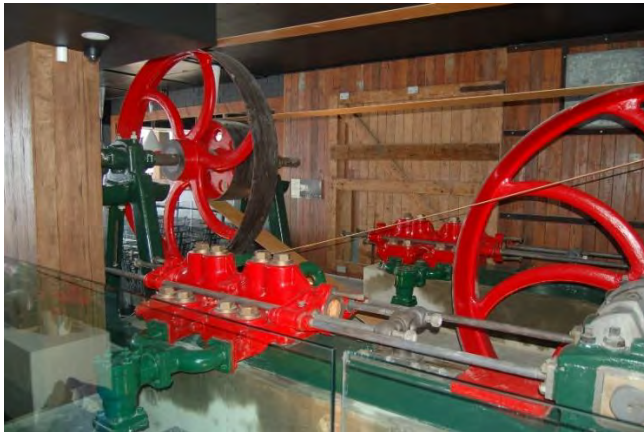


**Commonwealth Bank, Martin Place;
hydraulic door opening**

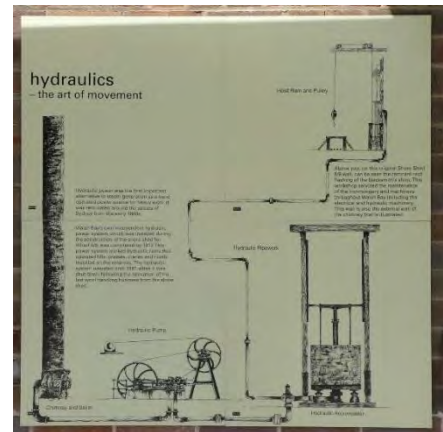


**Top of lift rams 185
Clarence Street**

Walsh Bay Hydraulic System



Steam pump



Hydraulics interpretation



Original accumulator



Reconstructed accumulator



Wool bale chute



Interpretation: wool bale chute

Garden Island Hydraulic System



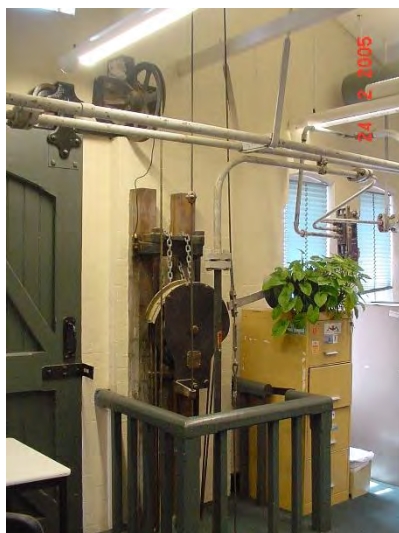
Garden Island, Building 89



External jib of whip



Bottom of whip cylinder



Whip fully extended

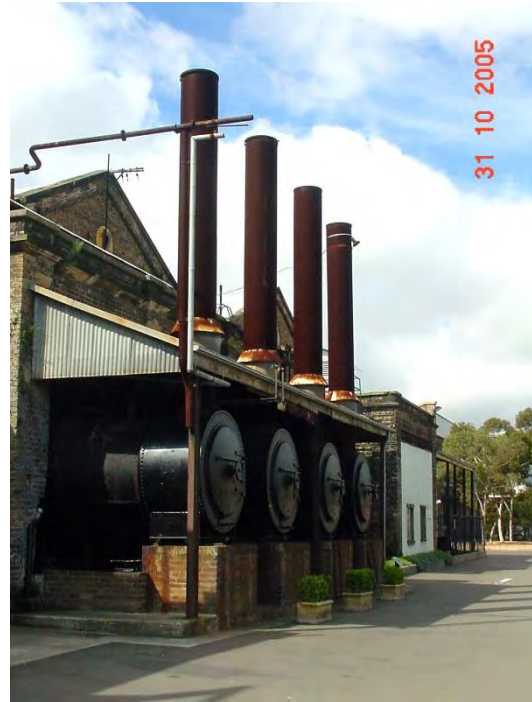


Whip partly extended

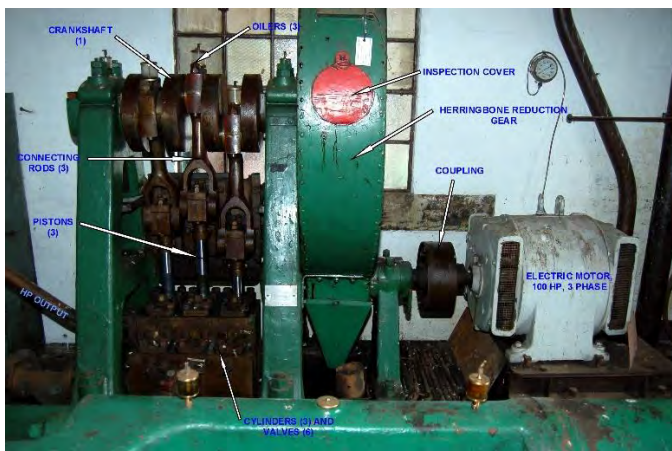
Eveleigh Railway Workshops Hydraulic System



Accumulators



Boilers



Hathorn pump – electrically driven



Davy Press



Original Fielding & Platt steam pump



Riveter - Allen Striker

Interpretation at old Rocks Police Station



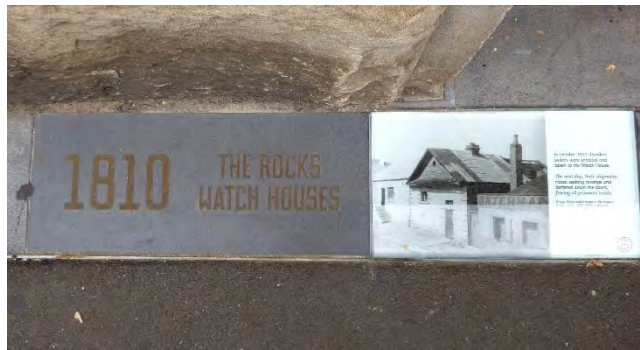
Old Rocks police station, built 1882



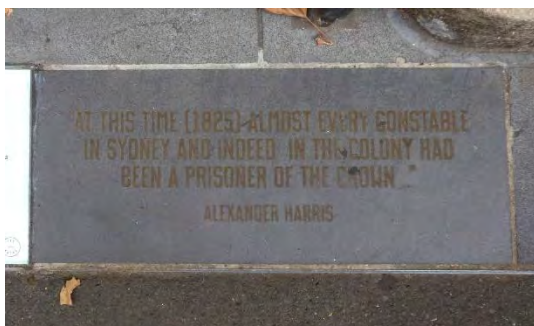
George Barrington ... arrested for pickpocketing ... in Britain ... later Chief Constable at Parramatta



12 well-behaved convicts were made night watchmen



1810 The Rocks watch houses. ... 1841 drunken sailors ... arrested. ... next day ... shipmates ... battered down doors, freeing all prisoners ...



... 1825 almost every constable ... had been a prisoner of the Crown



This building was designed by James Barnett ... to replace the Harrington Street Watch House. It closed in 1974.

Appendices

Appendix A

Garden Island Naval Dockyard, Hydraulic Installation

The hydraulic whip system on Garden Island was a stand-alone one, using the Island's water supply and power system; it is in Building 89 (now offices), which was the main Naval and victualing stores.

The system as it exists today consists of a water reservoir, a three-stage reciprocating hydraulic pump driven by an electric motor through a worm/wheel reduction gearbox, an accumulator, and piping to five separate whip valves and hydraulic cylinder units. The whip's hydraulic units are mounted on the inside of the building with the operating rope system passing through the walls to the five externally mounted jibs.

Each jib is capable of rotating about a vertical axis in an arc so that landing stages (at each of the four levels) would not obstruct loads while ascending or descending. The system of rope and sheaves has a mechanical advantage of four - two sheaves fixed, and two moveable sheaves.

The pump and reservoir are located on level one, the accumulator between levels one and two, and the hydraulic cylinders for the whips are between levels two and three. The jibs of the whips are located on the northern face of the building and service landings on each of the four levels, making a total of 20 loading stages.

In operation, water was pumped into the accumulator raising the piston with weights attached, and when the accumulator was full, the pump stopped. With the hook at ground level, when a load had to be lifted the valve on the relevant whip hoist-cylinder was opened admitting high pressure water (at 650psi) from the accumulator, thus extending its piston and pulling on the rope, causing the load to rise; when the load had reached the required landing stage the valve was closed thus holding the load in place while it was unhooked.

When the hook had to be lowered – with or without a load, the valve was turned in the opposite direction and as water drained back into the reservoir, the piston and the hook descended under gravity. When the water in the accumulator fell to a pre-determined level, it was automatically replenished by the pump.

Lifting loads could be very fast depending on the operator's control of the valves. It was this speed of lifting that gave rise to the name 'whip', as the load could fly up the building at great speed!

"The system operated up until 1979 when the function of the building changed to offices. However, because of its heritage significance, the system was restored and is now in operating condition. Garden Island Dockyard also has a second separate hydraulic system which has an industrial function only." (Mead, 1987, 45).

Appendix B

Eveleigh Railway Workshops, Hydraulic Power System

The hydraulic system at the Eveleigh Locomotive Workshops was installed possibly in 1886 - a year before they were opened, making it the oldest virtually complete system of its kind, surviving in Australia.

The system comprised a water supply, high-pressure pumps, two accumulators, safety and control valves, and high-pressure piping to feed riveters, spring-making machinery, and other machinery across the workshops; the water tank was on a high stand outside the pump house.

The accumulators had 10" diameter pistons in a cylinder loaded with static weights of 35 tons, which could move through a designated height of about 9 ft. The high-pressure pump would raise the accumulator piston to its full height with the weights creating a high pressure in the piping. As water was consumed by the machinery the piston would lower, and the pumps would start up and raise the accumulator piston once again. The accumulator was essentially a pressure regulator and supply source for machines 'down the line'. Two accumulators remain at Eveleigh.

Initially, the pumps were steam powered and directly connected to the double acting steam pistons. In 1914 a three-cylinder Hathorn Davey pump driven by an electric motor was installed, but the steam pump was left in place as a backup.

High-pressure water was piped around the workshops to operate machinery - at least from Bay 1 to Bay 8, for use by blacksmiths, forgers, and wheelwrights. The system in the Locomotive Workshops operated until 1987.

A second system operated in the General Carriage Shop (north Eveleigh) but that has been completely dismantled.

Some of the machinery operated by the hydraulic power system still exists in Bays 1 and 2 of the Australian Technology Park building which now occupies the site, and as display items in some of the other bays. Some examples include:

- Hydraulic spring buckling press made by Rice & Co. in 1915.
- Hydraulic spring buckling press made by Fielding & Platt in 1908.
- Hydraulic press and spring tester made at Eveleigh c1914.
- Hydraulic spring dissembler made at Eveleigh in 1887.
- Hydraulic ram press made by Tangye Bros.
- Hydraulic press made by Woodbury.
- Hydraulic Allen strikers (two off) made at Cardiff Junction Dry Dock & Engineering, Wales.
- The 1500-ton Davy Press used steam to lift the upper tup, and HP water for pressing. (The 'tups' are the top and bottom forging blocks in a hammer or press. The bottom tup is fixed, and the upper tup is moveable. The metal to be forged - at high temperature, is worked between the tups).

Appendix C

Notes and short history of the Sydney and Suburban Hydraulic Power Company

Formation:

- December 1888: Sydney and Suburban Hydraulic Power Co Ltd formed.
- 7 February 1890: Sydney and Suburban Hydraulic Power Co seeks City Council's permission to break up pavement and lay pipes.

The System 1891:

- John Coates elected to position of Chairman of Directors; T. Dickinson resident engineer; George Swinburne consulting engineer.
- No.1 pumping station constructed in Pier Street, Darling Harbour; buildings were characteristic of Industrial architecture of the day.
- Water supply initially from city's main and stored in a roof top tank holding 150,000 gallons.
- A dam constructed at Mt. Rennie, O'Dea Avenue, Waterloo, and water pumped to No.1 pumping station.
- The power-producing machinery consisted of three pairs of high-pressure pumps, four Lancashire boilers and two accumulators, each with 20-inch diameter rams.
- The operating pressure was 750 psi producing 1200 gal/min.
- The main customers at this time were warehouses and passenger lifts.

Applications for High Pressure power:

- 1) Lifting cranes
- 2) Wool Dumping presses
- 3) Passenger and Goods lifts
- 4) Jiggers (Whips).
- 5) Capstans at wharves, to help berth ships
- 6) Traversers in railway workshops.
- 7) Organ blowing - St. Andrews Cathedral.
- 8) Small lathes
- 9) Bank doors – Commonwealth Bank and other banks.

Business Growth and Decline:

- December 1890: 72 machines connected.
- 1894: 149 lifts, over just three years.
- December 1896: 245 machines connected.
- December 1903: 541 machines connected.
- April 1921: The pumping station at Waterloo is converted to work electrically.
- February 1923: A subsidiary (No.2) pumping station equipped with modern pumps had been built and at Woolloomooloo Wharves to meet the growing demand.
- 1926: Company name change to Hydraulic Power, Electric and Hydraulic Lifts.

- 1957: Height of Buildings Act that limited the height of city buildings to 150 ft, was repealed.
- 1965: Profit and loss break-even point.

Early Customers:

1891:	The first installation to use the system was Messrs John Bridge & Co. Sydney.
c1892:	Chief Secretary's Building.
c1894:	Lands Department Building.
c1905:	Grace Bros; Challis House; Stock Exchange; R. Chadwick; and Yarralla Chambers, all had hydraulic lifts; Anthony Hordern and Sons (21 hydraulic lifts in their 1905 New Emporium) – subject to check.
1920s:	State Theatre, Sydney; and Capitol Theatre, Haymarket.
1905:	Three electric powered lifts to be installed in Sydney's General Post Office.
1906:	Thirty-four hydraulic elevators are being replaced by electric powered lifts by the Standard Electric Elevator Co Ltd.
1919:	The life of an electric lift is from 10 to 20 years at the outside, while hydraulic lifts installed in Sydney 28 years before were still working well.
	Absolute reliability and continuity of service of the hydraulic lift.
1945:	The supply of hydraulic power to Sydney is threatened by a strike meeting by engine drivers employed by Hydraulic Power, Electric and Hydraulic lifts Ltd.
1952:	Pier St. pumping station converted to electrical power.
1954:	Company name change to Hydraulic Power Pty. Ltd. (Pugh, 1975, 2).

Appendix D

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